laboratory the work was mostly done. The detailed statement of results can of course not be summarized, but the general nature of them can be seen in the results of a series of experiments in which the changed color was directly compared with that produced by spectral light on another unfatigued portion of the retina. 1. After fatigue from Red (between line C and the red end of the spectrum) Violet (between G and H) appeared Bluish-green, of tone about like wave-length 478 $\mu\mu$. 2. After fatigue from this Violet, spectral Red appeared Reddish-yellow of tone about line D (wave-length 589.7 $\mu\mu$), or even beyond. 3. After fatigue from Red, Green (between E and b) appeared a Greenish-blue (489–488 $\mu\mu$). 4. After fatigue from the same Green, Red appeared Bluish-red. 5. After fatigue from Blue, (wave-length 442 $\mu\mu$), spectral Red appeared like a Reddish-yellow, of less than 600 $\mu\mu$ wave-length.

Now it is possible by taking the color triangles and curves for the sensations produced by spectral lights which Fick and others (most recently König) have drawn, to predict, according to the Young-Helmholtz theory, at least for fatigue from certain colors, both the direction and the extreme limits of change to be observed in other colors. This Hess does for the typical curves of König and Fick, finding the predictions not verified by the facts. In König's curve, for example, fatigue from Yellow (wave-length 575 $\mu\mu$), which depends on the equal stimulation of the red and green fibres, should have little effect on the appearance of the colors at the red end of the spectrum in which the blue fibres are not active. The actual effect, is however, that these colors become more or less bluish. Fatigue from Red should make Violet appear a little bluish, and complete fatigue, (enough to cause temporary red-blindness) should make it only blue. As a matter of fact a fatigue of 30 seconds makes Violet appear Greenish-blue.

If, however, as Helmholtz and Fick assume, *all three kinds of fibres* are active in case of *every* color, though in differing degree, discrepancies are not avoided. Fatigue from Green should cause equal fatigue for the red and blue fibres, thus no change in their proportions; from which it follows that Violet should undergo no change in tone. Experiment shows it to become redder. The extremest fatigue for Blue should change Red but little toward Yellow (a little beyond line C). As a matter of fact it changes it nearly to line D.

These examples are sufficient to show the difficulties which these experiments offer to the supporters of the three-color theory; to the four-color theory of Hering they apparently offer no difficulties.

Zur Diagnostik der Farbenblindheit. E. HERING. Archiv für Ophthalmologie. Bd. XXXVI, H. 1, S. 217-233.

After discussing a number of the commoner methods of testing for color-blindness, and showing that, while they answer well enough for determining deficiency, they are not suited to reveal complete defect, Hering lays down as conditions to be fulfilled the following: The colors with which the test is made must be of the fullest saturation; the areas of color must be of sufficient size; they must be without spots or roughness; they must be immediately adjacent to each other in an otherwise even and colorless field. With ordinary apparatus these conditions are difficult to satisfy or make the testing a very lengthy process. In *Pflüger's Archiv*, Bd. XLII, S. 119, Hering has described an arrangement of the dark room which serves well, and now he explains and illustrates by a couple of cuts a portable and rapid instrument for the same ends. In outline the scheme of the instrument is to place in the field of view of a vertical tube, two inclined mirrors, each occupying one-half, and each reflecting colored light, one green, the other red; the first adjustable in saturation, the second in saturation and color tone.

By these means an exact matching of colors (as they appear to the color-blind eye) can be made, either between red and green, or between red or green and gray. Besides showing the presence of complete red-green blindness, it also distinguishes the "red-blind" from the "green-blind" forms of red-green blindness, in Hering's words, the "*relativ blausichtiger Rothgrünblinder*" from the "*relativ Gelbsichtiger.*" It also seems capable of adaptation to other types of visual disturbance, some description of its application to which the author may publish on another occasion.

Die Untersuchung einseitiger Störungen des Farbensinnes mittels binocularer Farbengleichungen. E. HERING. Archiv für Ophthalmologie, Bd. XXXVI, (1890), H. 3, S. 1–23.

Of great interest for the theory of color vision are those cases in which color-blindness is confined to a single eye. In order, however, to yield the most exact and valuable results, the patient must not be asked to describe the colors of things seen, for this he often does inaccurately, but to match the colors seen with his color-blind eye alone with those seen at the same time with his normal eye alone. This is possible if an area of color is so presented to each eye that the one seen by the right eye is wholly invisible to the left eye, and *vice versa*, and if the two areas lie upon disparate retinal points, (*e. g.*, on the temporal halves of the eyes), and thus escape binocular combination. Under such circumstances, very delicate comparison of colors is possible. Under the title given above, Hering describes (with one illustration) an instrument for testing such cases, and reports the result of an application of it in the case of a woman whose vision on the right side was reduced by atrophy of the optic nerve to about one-half the normal acuteness, with marked disturbance of vision for colors. The tests showed that all colors appeared more whitish or grayish to the color-blind than to the normal eye; yellow and blue did not suffer any noticeable change in their color-tone; unsaturated primary red and green (Hering's *Urroth* and *Urgrün*) appeared colorless; the intermediate colors tried, (red of spectral tone, orange, yellow-green, and unsaturated violet), lost their red or green character entirely, and appeared whitish or grayish yellow or blue; white, gray and black were for both eyes the same. The red-green vision of the patient was, therefore, nearly destroyed, the blue-yellow vision much weakened. Other tests with spectral colors gave concurrent results. Tests of the acuteness of the patient's peripheral color-vision showed the color fields reduced in size; and careful tests of the same (made later) with the color-mixer, showed that the limits of the field for the members of each color pair were the same; red and green 5°, blue and yellow 30°. Still other tests showed that colors which matched for the sound eye, also matched (*i. e.*, both suffered equal change) for the defective eye. It is hardly necessary to say that these facts speak strongly for Hering's four-color theory and against the three-color theory of Helmholtz.

Untersuchung eines Falles von halbseitiger Farbensinnsstörung am linken Auge. C. HESS. Archiv für Ophthalmologie, Bd. XXXVI, (1890), H. 3, S. 24–36.

In the case of monocular color-blindness examined by Hess, the defect was still more limited than in Hering's case, occupying, indeed, only the nasal half of one retina. The patient was a man of about thirty years and near-sighted. The sharpness of vision in the affected eye (both supplied with proper glasses) was about one-half that of the other. The colors to be matched were this time presented, one to the nasal, the other to the temporal half of the single eye. Tests with pigment colors, homogeneous spectral lights and the perimeter gave results not essentially